1958-4
DIVISION
ACTIVITIES

VOLUME 84 NO. SM1
FEBRUARY 1958
PART 2

JOURNAL of the

Soil Mechanics and Foundations Division

PROCEEDINGS OF THE

AMERICAN SOCIETY
OF CIVIL ENGINEERS

1958-4 February, 1958 SM 1

DIVISION ACTIVITIES

SOIL MECHANICS AND FOUNDATIONS DIVISION

Proceedings of the American Society of Civil Engineers

NEWS

February, 1958

EARTH DAMS, SLOPES, AND OPEN EXCAVATIONS: A REPORT ON THE PROCEEDINGS OF THE INTERNATIONAL CONGRESS ON SOIL MECHANICS AND FOUNDATION ENGINEERING AT LONDON, ENGLAND, AUGUST 1957 PRESENTED AT THE OCTOBER 1957 MEETING OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS

BY FRED C. WALKER

As a general statement it is difficult to say that there is anything fundamentally new either in the papers submitted to this Congress or in the oral discussion presented. That is, it is highly probable that somewhere in existing literature a precedent comment can be found to match every contribution made to this Congress. What is noteworthy is the large increase in interest in this phase of Soil Mechanics, the volume of supporting data becoming available, and the extensive independent development of similar ideas and approaches to like problems that is occurring. In military language, soil mechanics in this phase is changing from a skirmish to a major campaign.

It is probable that about 500 papers have been written on this phase of soil mechanics since the meeting in Zurich, Switzerland in 1953. These contributions can be classified in several ways. One that appeals to me, that tends to divide the contributions according to the author's background is division into: Theories, empirical methods, and case histories. We find the theoretical developments originating primarily with those closely associated with educational institutions. The empirical procedures originate with those involved primarily in the commercial practice of engineering. The case history approach seems to be most attractive to the senior consultants.

In past practice similar procedures have been used for the stability evaluation of natural slopes, open excavations, and embankments. On the other hand it should be apparent external stress conditions in natural slopes are constant, they are decreasing as open excavations are made, and, they are increasing during the construction of fills. It appears desirable, therefore, to subdivide the contributions according to whether they concern natural slopes, open excavations, or embankments.

Failures in natural slopes have attracted a lot of attention in recent years. There is considerable improvement in the quality of reports. Whereas they originate primarily in the educational and research institutions, the approach

Note: No. 1958-4 is part of the copyrighted Journal of the Soil Mechanics and Foundations Division, Proceedings of the American Society of Civil Engineers, Vol. 84, SM 1, February, 1958.

most commonly used is that of providing case histories. Since failures can occur in natural slopes without a change in external stress conditions, failure must be accompanied by a change in shearing strength in the soils involved. Many contributors appear to be unaware of this although Professor Terzaghi stressed this point in his contribution to "Application of Geology to Engineering Practices—Berkey Volume" in 1949.

One of the prime purposes in the investigation of landslides is the improvement in stability analysis procedures. In general the investigators are finding that the stability procedures commonly used are proving to be unsatisfactory when applied to landslides, particularly the "phi equals zero" procedures which received so much support at the meeting in Zurich. It is believed that the fault is not so much with the method of analysis as it is with the procedures used to determine the soil strengths. The procedure most commonly used to determine soil strength is the unconfined compression test. To be strictly valid the test samples must be saturated. From a number of sources the comment has been raised that some of the strength commonly defined as cohesion results from capillary stresses in the soil. Some investigations indicate that rather high stresses develop the moment that the moisture film on the surface of saturated samples starts to withdraw into the pores and that, therefore, much higher strengths would be indicated by test than actually existed in the ground.

In other sections of the conference, attempts have been described that may lead to procedures by which the influence of capillary stresses can be evaluated. Some thought on the subject follows a path similar to that which led to the "phi equals zero" procedure when pore pressure was introduced, that is advocating a cohesion equals zero procedure.

To some it must have come as quite a shock to find that the unconfined compression test upon which they had been placing reliance is now suspected as being faulty. Again the idea is not new, there are many previous references that imply that the determination of soil strength cannot accurately be accomplished by such simple test procedures.

However, there are many soil problems where a simple test such as the unconfined compression test will suffice if only we know the range of its validity. For this purpose the case histories point a way toward establishing to some extent empirical rules for evaluating the stability of natural slopes. Studies on stable and unstable slopes in London Clay for example, indicate that strength in the ground may be only one-half the value indicated by test. Again we have a number of reports of natural slope failures where indicated safety factors approaching 2 were computed. These experiences indicate as a first approximation that if conventional "phi equals zero" practices are used, a safety factor of at least 2 should be required. Further experience may indicate a need of placing it still higher. On the other hand, if a smaller safety range is required more precise methods for determining soil strength must be used and the conditions which can result in a change in soil strength must be more thoroughly investigated.

Open cut problems continue to be solved primarily by the same empirical rules and by judgment that were in use before soil mechanics as such was recognized. There are few contributions which bear exclusively on this phase either from theoretical, empirical or case history methods of approach.

Since the process of making open cuts is primarily one of reducing stress, the foundation condition is always to some extent over consolidated. In general, attempts at developing theories of soil behavior in which over

consolidation is a factor have not progressed very far. Open cuts involve soils in their naturally deposited condition which may be complex and does not lend itself to theoretical simplification. It is not surprising, therefore, that this phase of soil mechanics has not received much attention from theorists.

Except for the very large or unusual operation involving open cut excavation few case histories are published and even these are more likely to be discussed as a construction operation rather than a problem of design. Most open cut problems do not individually represent a large part of the total cost of a project and, therefore, seldom receive attention from senior consultants. The result is that, faced with such situations as the major highway construction program in the United States and ship canal construction in Europe, the engineer cannot find much guidance in the literature and must fall back on his own experience which may be limited.

It appears, therefore, that improvement of engineering practices with regard to the design of open cuts offers a fertile field for further development that is not being explored to the extent that future requirements warrant. It was suggested that basic to such development would be improved methods for describing soil structure as contrasted to soil as a material.

The field of embankment design offers the most attractive area for discussion within the scope of this section. Since the engineer can to some extent control the material in the embankment both by selection and placement procedure this area is attractive to the theorists. It is attractive to the practicing engineer because opportunities for substantial savings of money through ingenuity is possible. It is also of interest from the standpoint of case histories since each embankment problem is sufficiently individual to draw attention.

It is not surprising, therefore, that the bulk of the contributions fall in this category and that each of the experience groups is well represented.

From a theoretical standpoint contributions range from mathematical analyses so complex that they require the use of electronic computers for their solution, through critical inspection of details of structural analysis, to abstract appraisals of the whole process of soil behavior. It is difficult to evaluate these contributions. Sometimes the evaluation is dependent upon a concept of soil behavior that is still controversial, and sometimes the theoretical appraisal is predicated upon simplifying assumptions that are not always acceptable, at least, within the special range of practice of a working engineer. There is a lot of food for thought in these theoretical contributions and some ideas when developed further and explained in a way that the ordinary engineer can understand will no doubt prove to be useful contributions.

Contributions to embankment construction in the empirical class range from mechanical devices for aiding a design analysis, through descriptions of special design features considered necessary for particular types of soil to special or unusual construction methods that are attractive under certain physical or climatic conditions. The wide variety of soils that are being used in embankments lead me to believe that somewhere one can find support for utilizing just about any kind of soil likely to be encountered for embankment construction.

A common difficulty facing the engineer who must depend on the literature to supplement his experience in designing an embankment is that whereas he can find much describing what was done, he can find little that describes how these ideas turned out in operation. There are quite a few contributions

describing examination of existing structures that are helpful in correcting this shortcoming. These various case histories provide a lot of meat for theoretical study to provide general rules for our guidance as well as details for application to particular projects.

There is a growing awareness that large masses of soil will have properties spread over a range of values, that behavior in a structure may be different from that experienced in the laboratory, and that the product produced in large scale construction may differ considerably from that developed in the laboratory. However, there is still little being said about the allowances the practicing engineer uses to overcome these difficulties. No doubt he makes some type of compensation for variation in his design studies. Just how this is done remains a mystery hidden in what is called engineering judgment or experience. The reporter's efforts to bring this point out into the open did not meet with much success.

In conclusion it appears that while there does not appear to have been much advance in the fore front of our knowledge on how to handle problems involving natural slopes, open cuts, and embankments, the general level of intelligence of workers in this field has advanced remarkably.

Because of the large number of workers in this field the need for improved methods for communication of experience is necessary. This involves not so much an increase in published information of which there is already too much to digest, as it does of finding a common terminology. The classification system originated by Casagrande is being accepted quite widely and descriptions of materials are, therefore, quite informative. The description of soil conditions in place on the other hand is still so varied that we have difficulty in visualizing the pertinent situation a writer describes unless we have actually seen it.

Further information is necessary on the range of variation of soil properties due to test procedures, variation within a soil area involved in a design, variation due to changes in environment, and variation due to practical limitations to accomplishing idealized conditions during construction. Until these factors can be further clarified selection of preferred methods of analysis from among the numerous proposals already available seems futile.

The Eleventh Canadian Soil Mechanics Conference

Pile Foundations and Frost Action were featured at the 11th Canadian Soil Mechanics Conference, held in Ottawa on 9th and 10th December. More than 200 engineers, contractors, geologists and soil scientists attended the meeting which was sponsored by the Associate Committee on Soil and Snow Mechanics of the National Research Council.

The program of the first day was devoted to the subject of the bearing capacity of pile foundations and a visit to the Soil Mechanics Laboratory of the Division of Building Research. The pile session was introduced by a paper prepared by Prof. I. F. Morrison and S. R. Sinclair of the University of Alberta. The paper reviewed was "Some Aspects of Pile Foundations" and was followed by a vigorous discussion.

Much interest was shown in the specifications for acceptance of wooden piles. Concern was expressed that when using crooked piles dynamic stresses during driving could exceed the ultimate strength of the outer fibres. Design considerations of lateral support for long slender piles were discussed and

the question of corrosion of steel piles was raised. Attention was directed to recent work on corrosion in Norway. An interesting argument, pro and con, on the use of pile driving formulae developed. There was general agreement that the formulae were useful for determining the bearing capacity of piles in clean, granular soils and as specification for refusal.

A panel consisting of Prof. D. F. Coates, Charleston University, as moderator, Dr. G. G. Meyerhof, Nova Scotia Technical College, Mr. C. V. Antenbring, Cowin & Co., Winnipeg, Mr. E. I. Rubinsky, Raymond Concrete Pile Company, Mr. L. A. Fraikin, Franki Pile Company, and Mr. N. D. Lea, Foundation of Canada Engineering Corporation Ltd. then took up the subject.

Following a statement on "What is Pile Failure" the panelists discussed special cast-in-place piles (which are used extensively in Western Canada), the use of friction piles in soft clays, the bearing capacity of rammed-in-place concrete piles and some aspects of the National Building Code concerning the soil bearing capacity of piles. Subsequent discussion illustrated the design difficulties associated with friction piles and with establishing a satisfactory value for end bearing piles. The two main problems, of ultimate bearing capacity and settlement, were fully discussed and it was generally concluded that load tests were the best means of evaluating pile capacity.

The program on 10th December was devoted to frost action in soils. The first paper by E. Penner, Division of Building Research, summarized experimental findings on the conditions necessary for the growth of ice crystals in soil. This was followed by a description of the frost problem as it affects maintenance and operation of the Quebec North Shore & Labrador Railway by Mr. R. W. Pryer, the soils engineer of the railway. Mr. E. B. Wilkins, B. C. Department of Highways, then presented a paper on the design of flexible pavements considering the effects of seasonal variations in road bearing capacity caused by frost action.

Mr. J. J. Hamilton of the Division of Building Research, described an interesting case of severe damage to a cold storage plant caused by frost action. After 4 or 5 years of satisfactory operation the building began to heave at the centre and in less than 2 years the heave amounted to more than one foot. Temperature measurements showed that when the frost line penetrated to the footing level (and the level of fine-grained soil) the heaving became rapid. Corrective measures were explained and the plant is now back to its original level. A practical mathematical analysis of the general problem of heat flow under cold storage plants was presented by Dr. D. C. Pearce of the Division of Building Research.

Discussion on Frost Action covered a wide range of subjects. Much interest was shown in the relationships of loss of bearing capacity of highways to changes in density and water content of the supporting soil. The application of chemical treatment was considered at length.

The proceedings of the Conference will include summaries of the papers presented and will appear in the Technical Memorandum series of the A.C.S.S.M. It will be available in the spring of 1958.

Joint Meeting of Committee D-18 of the A.S.T.M. and the Mexican Society of Soil Mechanics - December 9 to 13

Approximately 100 engineers representing both of the sponsoring organizations as well as a number of guests were in attendance when the four-day

session was opened by Co-Chairmen, Dr. Leonardo Zeevaert and Wesley G. Holtz. The welcoming address was made by Dr. Nabor Carillo, an outstanding worker in the field of Soil Mechanics, who is now Director of the magnificent University of Mexico.

Papers which were presented followed the program presented in the November issue of the Newsletter. Copies of the Proceedings containing the papers in both Spanish and English can be obtained at $3.00 each (U.S. Currency) from the organizing committee.

A highlight of the convention was an all day tour from Soil Mechanics point of view within the valley of Mexico. Classic examples of settlement problems were inspected as were results of the disastrous earthquake experienced in July 1957.

The hospitality of the Mexican Society of Soil Mechanics insured a most enjoyable meeting and visit for all who participated.

Soil Mechanics and Foundation Activities in the Los Angeles and San Francisco Areas

The following items which report on meetings held last fall indicate subjects, speakers and interest in the western area.

Mr. Neill Parker of the Los Angeles Local Section Soil Mechanics Group reports a September, 1957 meeting on "Soil Mechanics for Earth Dams" at which the speaker was Karl V. Taylor of the Bechtel Corporation. Some 70 members and guests who were in attendance heard Mr. Taylor discuss the many problems associated with soils exploration, testing, and design for earth dams and compare soil mechanics for foundations and soil mechanics for earth dams.

In the San Francisco area there have been a number of meetings devoted to matters pertaining to the activities of this Division by various local sections of national societies. On the 12th of September the Society of American Military Engineers had a program on the Coyote Dam project near Ukiah, California. Speakers were Colonel J. S. Harnett who is the District Engineer for the San Francisco District, Corps of Engineers and Grant P. Gordon, Vice President of the Guy F. Atkinson Company who are contractors for the Coyote Dam. This is a curved earth fill structure with a crest length of 3500 feet and a height of 160 feet above stream bed. The outstanding feature of the project to date has been the speed with which the contractor has operated. The job was started in June of 1956 and by June 1957 the contractor was moving earth and rock at the rate of 60,000 cubic yards per day. Total contract quantity is 6 million cubic yards of earth and rock.

A considerable amount of interest has been shown in the construction by the Corps of Engineers, of a large scale model of San Francisco Bay which has just recently been put into operation. Many problems relating to soil mechanics, sediment deposition and foundations along the shores of San Francisco Bay will be studied in the coming years. A number of excursions have been made to the model which is now open several days a week to the public. An excellent article by Colonel J. A. Graff, describing the model which is located at the South Pacific Division Laboratory in Sausalito, California, is contained in the "Military Engineer" of September-October, 1957.

A meeting was held by the Soil Mechanics and Foundations Division of the San Francisco Section on November 6, 1957. The technical program was

presented by Mr. C. R. Graff of the Raymond Concrete Pile Company on the subject "Dynamic Forces in Pile Driving." The talk included a discussion on many of the well known pile driving formulas and their inadequacies. In addition, Mr. Graff described briefly the application of electronic computers for solving for dynamic stresses in piles utilizing the wave equations developed originally by Timoshenko.

Northwestern Section Soils Conference

The Sixth Annual Soils Conference sponsored by the Northwestern Section, American Society of Civil Engineers, and the University of Minnesota will be held Thursday, April 3, 1958. Registration information may be obtained from the University of Minnesota, Center for Continuation Study, Minneapolis 14, Minnesota.

Topics to be covered in this one day conference include fundamentals of soil compaction, by Mr. S. T. Thorfinnson of the Corps of Engineers, Omaha District, and analysis of soil slides by Dr. Miles Kersten, Professor of Soil Engineering, University of Minnesota.

The other subjects that will be discussed by nationally known speakers, but not yet for release, will be dewatering and chemical solidification of soil.

Colorado Section of the Soil Mechanics and Foundation Division

Mr. K. P. Karpoff relinquished his chairmanship at the October meeting because he was transferred to the Glen Canyon project by the Bureau of Reclamation. Mr. William A. Clevenger has been acting chairman since that time.

The speaker at the October 9th meeting was Mr. H. T. Gibbs, Head of Earth Special Investigation and Research, U. S. Bureau of Reclamation, Denver, who gave a review of a course taught at M.I.T. this past summer entitled "Soil Engineering in Frost Areas." The discussion was illustrated. There were 21 members and guests in attendance.

At the November 6th meeting the speaker was Mr. William R. Judd, Engineering Geologist at the U. S. Bureau of Reclamation, Denver, who presented an informative lecture on "Exploration Logistics in Alaska." He supported his talk with a fine selection of colored slides. The talk highlighted the character and difficulties of undertaking preliminary exploration programs in the relatively virgin country of southwestern Alaska. Utilization of modern airlift techniques was emphasized together with the high costs of exploration under these conditions.

The speaker for the December 4th meeting was Mr. W. W. Daehn, Supervisory Engineer, Earth Dam Section, U. S. Bureau of Reclamation, Denver. His topic was "Instrumentation for Performance Studies of Earth Dams." He explained the types of equipment used, their method of installation and the character and use of the results obtained.

The Colorado Section of the division invites everyone in the Denver vicinity interested in Soil Mechanics and Foundations to attend these monthly meetings which are normally held on the first Wednesday of the month at 7:30 p.m. in the basement of the Stearns-Roger Building, 660 Bannock Street, Denver, Colorado. Specific information can be obtained by calling the Secretary, J. G. Johnstone, at CRestview 9-3381. extension 330.

Pittsburgh Section Conference

The Pittsburgh Local Section Committee on Soil Mechanics and Foundations is planning a conference on the Subject of "Mine Subsidence in the Pittsburgh Area," to be held at Clapp Hall, University of Pittsburgh on the nights of April 8, 10, 15, 17. The following subjects will be covered:

April 8

Geology - S. S. Philbrick
Exploration Methods - F. C. Sturges

April 10

Mining in the Pittsburgh Area - H. Rose
Mine Fires and Their Prevention - F. E. Griffith
Mining and Preparation - J. J. Dowd

April 15

Mechanics of Subsidence, E. Dappolonia
Cause and Prevention

Surface Effects and Data A. C. Ackenheil
on Subsidence

April 17

Legal Aspects - J. J. Matthews

ASCE-GSA Committee on Engineering Geology Meeting

This is a brief report of the meeting of the ASCE-GSA Committee on Engineering Geology, held October 18, 1957, during the ASCE New York Meeting. The following members were present:

A. Cleaves, P. Trask both representing GSA
H. Ireland
W. Judd
K. Terzaghi
T. Thornburn
Dr. R. Peck sat in on the latter half of the meeting.

In view of the inaction of two of our four Task Committees and, because of difficulties that had arisen, it was agreed to reorganize the entire committee. The proposed plan consists of elimination of the Task Committees as such; their duties will be carried on by various members of the Administrative Committee. The latter will call on the former members of the Task Committees on an informal basis for assistance from time to time as the occasion arises.

The principal emphasis will be given to preparation of papers and their presentation at meetings of the ASCE and GSA. Research projects formerly undertaken by the Task Committees will continue only insofar as they happen to be coincident with the afore-mentioned papers.

Future plans call for a symposium to be presented at one of the near-future ASCE annual meetings. Also the GSA has requested that we present a group of papers on rock mechanics at their 1958 annual meeting in St. Louis. It was

agreed that Dr. Cleaves as former chairman of the Task Committee on Tunnels will continue to collect case histories on tunnels; these will be published by the GSA as part of their recently instituted program of case history publications.

The newly reorganized committee will be chairmanned by Professor Thomas Thornburn of the Department of Civil Engineering at the University of Illinois. Additional membership of the Administrative Committee is not yet fully determined. The change of officers and organizations will be made, subject to the approval of the Executive Committee of the Soil Mechanics and Foundation Division.

Pan American Congress on Soil Mechanics and Foundation Engineering

Mexico is extending an invitation to all American countries to participate in a Pan-American Soil Mechanics meeting which they are planning for the first week of September 1958 in Mexico City. There have been European meetings in recent years which were held in between the International Conferences. The proposal to hold similar Pan-American meetings deserves our hearty support. Further details about the meeting in Mexico City, and how to submit contributions, will be published in Civil Engineering.

Honorary Degree Department

Congratulations to Dr. P. C. Rutledge for his award of an Honorary Doctor's Degree from Purdue University for his work in soils.

New Lineup for Division Executive Committee

During 1958 the following men will make up our Division Executive Committee:

Chairman: Ralph E. Fadum (1959) - Frost
Secretary: Jorj O. Osterberg
T. Leps (1961) - Earth and Rockfill Dams, Roads and Airfields
Stanley Johnson (1960) - Grouting, Ground Water
Ralph B. Peck (1958) - Publications, Geology

MAY NEWSLETTER

Deadline date for arrival at this office of contributions for the May Newsletter: March 20, please.

Bernard B. Gordon, Assistant Editor
Porter, Urquhart, McCreary, and O'Brien
1140 Howard Street
San Francisco 3, California

Alfred C. Ackenheil, Editor
Department of Civil Engineering
University of Pittsburgh
Pittsburgh 13, Pennsylvania